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GSO 220 (1994) (English): INDUSTRIAL SAFETY AND
HEALTH REGULATIONS - WELDING, CUTTING AND BRAZING



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GSO 220/1994

اشتراطات السلامة والصحة الصناعية

اللحام والقطع واللحام بالنحاس الأصفر

**INDUSTRIAL SAFETY AND HEALTH REGULATIONS -
WELDING, CUTTING AND BRAZING**

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INDUSTRIAL SAFETY AND HEALTH REGULATIONS - WELDING, CUTTING AND BRAZING

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INDUSTRIAL SAFETY AND HEALTH REGULATIONS - WELDING CUTTING AND BRAZING

1. SCOPE AND FIELD OF APPLICATION

This standard is concerned with industrial safety and health regulations - welding, cutting and brazing.

2. COMPLEMENTARY REFERENCES

- 2.1 GSO 215/1994 "Industrial Safety and Health Regulations - Equipment Tanks, Pressure Vessels, Boilers and Compressed Gas Equipment".
- 2.2 GSO 218/1994 "Industrial Safety and Health Regulations - Electrical - Low Voltage".
- 2.3 GSO 63/1987 "Industrial Safety and Health Regulations - Hazardous Materials - Flammable and Combustible Liquids - Part 2 - Container and Portable Tank Storage".
- 2.4 GSO 212/1994 "Industrial Safety and Health Regulations - Personal Protective Equipment".
- 2.5 Gulf standard which will be approved by GSO concerned with " Industrial Safety and Health Regulations Hazardous Materials.- Toxic and Hazardous Substances".
- 2.6 GSO 209/1994 "Industrial Safety and Health Regulations - Occupational Health and Environmental Control".

3. DEFINITIONS

No specific definitions are required.

4. REQUIREMENTS

- 4.1 Gas
 - 4.1.1 General
 - 4.1.1.1 No device or attachment facilitating or permitting mixtures of air or oxygen with flammable gases prior to consumption, except at the burner or in a standard torch, shall be allowed unless approved for the purposes.
 - 4.1.1.2 Acetylene shall not be generated, piped (except in approved cylinder manifolds) or utilized at a pressure in excess of 1.05 kg/sq cm pressure. This requirement is not intended to apply to storage of acetylene dissolved in a suitable solvent in cylinders. The use of liquid acetylene shall be prohibited.
 - 4.1.1.3 Only approved apparatus designed for the purpose such as torches, regulators or pressure reducing valves, acetylene generators, and manifolds shall be used.

- 4.1.1.4 Workmen in charge of the oxygen or fuel-gas supply equipment, including generators, and oxygen or fuel-gas distribution piping systems shall be instructed and judged competent by their employers for this work before being left in charge. Rules and instructions covering the operation and maintenance of oxygen or fuel-gas supply equipment including generators, and oxygen or fuel-gas distribution piping systems shall be readily available.
- 4.1.2 Cylinders and containers
 - 4.1.2.1 Approval and marking
 - 4.1.2.1.1 All portable cylinders used for the storage and shipment of compressed gases shall be constructed and maintained in accordance with good engineering practice.
 - 4.1.2.1.2 Compressed gas cylinders shall be legibly marked in accordance with Gulf standard mentioned in item 2.1.
 - 4.1.2.1.3 Compressed gas cylinders shall be equipped with connectors suitable for the purposes. All cylinders with a water weight capacity of over 14 kg shall be equipped with means of connecting a valve protection cap or with a collar or recess to protect the valve.
 - 4.1.2.2 Storage of Cylinders - General
 - 4.1.2.2.1 Cylinders shall be kept away from sources of heat. Inside buildings, cylinders shall be stored in a well protected, well ventilated, dry location, at least 6 m from highly combustible materials such as oil or excelsior. Cylinders shall be stored in definitely assigned places away from elevators, exits, stairs, or gangways. Assigned storage spaces shall be located where cylinders will not be knocked over or damaged by passing or falling objects, or be subject to tampering by unauthorized persons. Cylinders shall not be kept in unventilated enclosures such as lockers or cupboards.
 - 4.1.2.2.2 Empty cylinders shall have their valves closed. Valve protection caps, where cylinder is designed to accept a cap, shall always be in place, hand-tight, except when cylinders are in use or connected for use.
 - 4.1.2.3 Fuel-Gas Storage
 - 4.1.2.3.1 Inside a building, cylinders, except those in actual use or attached ready for use, shall be limited to a total gas capacity of 57 cu m or 140 kg of liquefied petroleum gas. For storage in excess of 57 cu m total gas capacity of cylinders or 140 kg of liquefied petroleum gas, a separate room or compartment conforming to the requirements specified in item 4.1.6.6 shall be provided, or cylinders shall be kept outside or in a special building. Special buildings, rooms or compartments shall have no open flame for heating or lighting and shall be ventilated. Signs should be conspicuously posted in such rooms reading "DANGER NO SMOKING, MATCHES OR OPEN LIGHTS, or other equivalent wording.
 - 4.1.2.3.2 Acetylene cylinders shall be stored with valve end up.
 - 4.1.2.4 Oxygen Storage
 - 4.1.2.4.1 Oxygen cylinders shall not be stored near highly combustible materials, especially oil and grease; or near reserve stocks of carbide and acetylene or other fuel-gas

cylinders, or near any other substance likely to cause or accelerate fire, or in an acetylene generator compartment.

- 4.1.2.4.2 Oxygen cylinders stored in outside generator house shall be separated from the generator or carbide storage rooms by a noncombustible partition having a free-resistance rating of at least 1 hour. This partition shall be without opening and shall be gastight.
- 4.1.2.4.3 Oxygen cylinders in storage shall be separated from fuel-gas cylinders or combustible materials (especially oil or grease), by a minimum distance of 6 m or by a noncombustible barrier at least 1.5 m high having a fire resistance rating of at least one and half hour.
- 4.1.2.5 Operating Procedures
 - 4.1.2.5.1 Cylinders, cylinder valves, couplings, regulators, hose and apparatus shall be kept free from oily or greasy substances. Oxygen cylinders or apparatus shall not be handled with oily hands or gloves. A jet of oxygen must never be permitted to strike an oily surface, greasy clothes, or enter a fuel oil or other storage tanks.
 - 4.1.2.5.2 Valve-protection caps, where cylinder is designed to accept a cap, shall always be in place.
 - 4.1.2.5.3 Cylinders shall not be dropped or struck or permitted to strike each other violently.
 - 4.1.2.5.4 Valve-protection caps shall not be used for lifting cylinders from one vertical position to another. Unless cylinders are secured on a special truck, regulators shall be removed and valve-protection caps, when provided for, shall be put in place before cylinders are moved.
 - 4.1.2.5.5 Cylinders not having fixed hand wheels shall have keys, handles, or nonadjustable wrenches on valve stems while these cylinders are in service. In multiple cylinder installations only one key or handle is required for each manifold.
 - 4.1.2.5.6 Cylinder valves shall be closed before moving cylinders.
 - 4.1.2.5.7 Cylinder valves shall be closed when work is finished.
 - 4.1.2.5.8 Valves of empty cylinders shall be closed.
 - 4.1.2.5.9 Cylinders shall be kept far enough away from the actual welding or cutting operation so that sparks, hot slag, or flame will not reach them, or fire-resistant shields shall be provided.
 - 4.1.2.5.10 Cylinders shall not be placed where they might become part of an electric circuit. Cylinders shall be kept away from radiators, piping systems, and layout tables that may be used for grounding electric circuits such as for arc welding machines. Any practice such as the tapping of an electrode against a cylinder to strike an arc shall be prohibited.
 - 4.1.2.5.11 Cylinders shall never be used for any purpose other than to contain whether full or empty.
 - 4.1.2.5.12 The numbers and markings stamped into cylinders shall not be tampered with.

- 4.1.2.5.13 No person, other than the gas supplier, shall attempt to mix gases in a cylinder. No person, except the owner of the cylinder or person authorized by him, shall refill a cylinder.
- 4.1.2.5.14 No one shall tamper with safety devices.
- 4.1.2.5.15 Cylinders shall not be dropped or otherwise roughly handled.
- 4.1.2.5.16 Unless connected to a manifold, oxygen from a cylinder shall not be used without first attaching an oxygen regulator to the cylinder valve.
- 4.1.2.5.17 Fuel-gas shall never be used from cylinders through torches or other devices equipped with shutoff valves without reducing the pressure through a suitable regulator attached to the cylinder valve or manifold.
- 4.1.2.5.18 A hammer or wrench, except special wrench, shall not be used to open cylinder valves. If valves cannot be opened by hand, the supplier shall be notified.
- 4.1.2.5.19 Cylinder valves shall not be tampered with nor should any attempt be made to repair them. If trouble is experienced, the supplier should be sent a report promptly indicating the character of the trouble. Supplier's instructions as to its disposition shall be followed.
- 4.1.2.5.20 Complete removal of the stem from a diaphragm-type cylinder valve shall be avoided.
- 4.1.2.5.21 Fuel-gas cylinders shall be placed with valve end up whenever they are in use.
- 4.1.2.5.22 Before connecting regulator to a cylinder valve, the valve shall be opened slightly and closed immediately. The valve shall be opened while standing to one side of the outlet; never in front of it. Never crack a fuel-gas cylinder valve near other welding work or near sparks, flame, or other possible sources of ignition.
- 4.1.2.5.23 Before a regulator is removed from a cylinder valve, the cylinder valve shall be closed and the gas released from the regulator.
- 4.1.2.5.24 Nothing shall be placed on top of a cylinder when in use which may damage the safety device or interfere with the quick closing of the valve.
- 4.1.2.5.25 If cylinders are found to have leaky valves or fittings which cannot be stopped by closing of the valve, the cylinders shall be taken outdoors away from sources of ignition and slowly emptied.
- 4.1.2.5.26 A warning should be placed near cylinders having leaking fuse plugs or other leaking safety devices not to approach them with a lighted cigarette or other source of ignition. Such cylinders shall be plainly bagged; the supplier shall be promptly notified and his instructions followed as to their return.
- 4.1.2.5.27 The cylinder valve shall always be opened slowly.
- 4.1.2.5.28 An acetylene cylinder valve shall not be opened more than one and one-half turns of the spindle, and preferably no more than three-fourths of a turn.
- 4.1.2.5.29 Where a special wrench is required it shall be left in position on the stem of the valve while the cylinder is in use so that the fuel-gas flow can be quickly turned off in case of emergency. In the case of manifold or coupled cylinders at least one wrench shall always be available for immediate use.

- 4.1.3 Manifolding of Cylinders
 - 4.1.3.1 Fuel-Gas Manifolds
 - 4.1.3.1.1 Manifolds shall be approved either separately for each component part or as an assembled unit.
 - 4.1.3.1.2 Except as provided in the following paragraph, fuel-gas cylinders connected to one manifold inside a building shall be limited to a total capacity not exceeding 136 kg of liquefied petroleum gas or 85 cu m of other fuel-gas. More than one such manifold with connected cylinders may be located in the same room provided the manifolds are at least 15 m apart or separated by a noncombustible barrier at least 1.5 m high having a fire-resistance rating of at least one-half hour. Fuel-gas cylinders connected to one manifold having an aggregate capacity exceeding 136 kg of liquefied petroleum gas or 85 cu m of other fuel-gas shall be located outdoors, or in a separate building or room constructed in accordance with item 4.1.6.6.
 - 4.1.3.1.3 Separate manifold building or room may also be used for the storage of drums of calcium carbide and cylinders containing fuel gases as provided in item 4.1.2.3. Such buildings or rooms shall have no open flames for heating or lighting and shall be well-ventilated. High-pressure fuel-gas manifolds shall be provided with approved pressure regulating devices.
 - 4.1.3.2 High Pressure Oxygen Manifolds (for use with cylinders having a service pressure above 14 kg/sq cm)
 - 4.1.3.2.1 Oxygen manifolds shall not be located in an acetylene room.
 - 4.1.3.2.2 Oxygen manifolds shall be separated from fuel-gas cylinders or combustible materials (especially oil or grease), by a minimum distance of 6 m or by a noncombustible barrier at least 1.5 m high having a fire-resistance rating of at least one-half hour.
 - 4.1.3.2.3 Except as provided in the following subparagraph, oxygen cylinders connected to one manifold shall be limited to a total gas capacity of 170 cu m. More than one such manifold with connected cylinders may be located in the same room provided the manifolds are at least 15 m apart or separated by a noncombustible barrier at least 1.5 m high having a fire-resistance rating of at least one-half hour.
 - 4.1.3.2.4 An oxygen manifold, to which cylinders having an aggregate capacity of more than 170 cu.m of oxygen are connected, shall be located outdoors or in a separate noncombustible building. Such a manifold, if located inside a building having other occupancy, shall be located in a separate room or noncombustible construction having a fire-resistance rating of at least one-half hour or in an area with no combustible material within 6 m of the manifold.
 - 4.1.3.2.5 High pressure oxygen manifold shall be provided with approved pressure-regulating devices.
 - 4.1.3.3 Low Pressure Oxygen Manifolds (for use with cylinders having a service pressure not exceeding 14 kg/sq cm)

- 4.1.3.3.1 Manifolds shall be of construction suitable for use with oxygen at a pressure of 17 kg/sq.cm. They shall have a minimum bursting pressure of 70 kg/sq cm and shall be protected by a safety relief device which will relieve at a maximum pressure of 35 kg/sq cm.
- 4.1.3.3.2 Hose and hose connections subject to cylinder pressure shall comply with item 4.1.5.5. Hose shall have a minimum bursting pressure of 70 kg/sq cm.
- 4.1.3.3.3 The assembled manifold including leads shall be tested and proven gas-tight at a pressure of 21 kg/sq cm. The fluid used for testing oxygen manifolds shall be oil-free and not combustible.
- 4.1.3.3.4 The following sign shall be conspicuously posted at each manifold:

LOW-PRESSURE MANIFOLD
DO NOT CONNECT HIGH-PRESSURE CYLINDERS
MAXIMUM PRESSURE - 17 kg/sq cm.

- 4.1.3.4 Portable Outlet Headers
 - 4.1.3.4.1 Portable outlet headers shall not be used indoors except for temporary service where the conditions preclude a direct supply from outlets located on the service piping system.
 - 4.1.3.4.2 Each outlet on the service piping from which oxygen or fuel-gas is withdrawn to supply a portable outlet header shall be equipped with a readily accessible shut off valve.
 - 4.1.3.4.3 Hose and hose connections used for connecting the portable outlet header to the service piping shall comply with item 4.1.5.5.
 - 4.1.3.4.4 Master shut off valves for both oxygen and fuel-gas shall be provided at the entry end of the portable outlet header.
 - 4.1.3.4.5 Portable outlet headers for fuel-gas service shall be provided with an approved hydraulic back-pressure valve installed at the inlet and preceding the service outlets, unless an approved pressure-reducing regulator, an approved back-flow check valve, or an approved hydraulic back-pressure valve is installed at each outlet.
 - 4.1.3.4.6 Each service outlet on portable outlet headers shall be provided with a valve assembly that includes a detachable outlet seal cap, chained or otherwise attached to the body of the valve.
 - 4.1.3.4.7 Portable outlet headers shall be provided with frames which will support the equipment securely and protect them from damage during handling and operation.
- 4.1.3.5 Manifold Operating Procedures
 - 4.1.3.5.1 Cylinder manifolds shall be installed under the supervision of a person familiar with standard practices.

- 4.1.3.5.2 All component parts used in the methods of manifolding shall be approved by the manufacturer as to materials, design and construction either separately or as an assembled unit.
- 4.1.3.5.3 All manifolds and parts used in methods of manifolding shall be used only for the gas or gases for which they are approved.
- 4.1.3.5.4 When acetylene cylinders are coupled, approved flash arresters shall be installed between each cylinder and the coupler block for outdoor use only, and when the number of cylinders coupled does not exceed three, one flash arrestor installed between the coupler block and regulator is acceptable.
- 4.1.3.5.5 Each fuel-gas cylinder lead shall be provided with a back flow check valve.
- 4.1.3.5.6 The aggregate capacity of fuel-gas cylinders connected to a portable manifold inside a building shall not exceed 85 cu m of gas.
- 4.1.3.5.7 Acetylene and liquified fuel-gas cylinders shall be in a vertical position when manifolded.
- 4.1.3.5.8 The pressure in the gas cylinders connected to and discharged simultaneously through a common manifold shall be approximately equal.
- 4.1.4 Piping Systems
 - 4.1.4.1 Materials and Design
 - 4.1.4.1.1 Piping and fittings shall comply with good engineering practice.
 - 4.1.4.1.2 Piping shall be steel, wrought iron, brass or copper pipe, or seamless copper, brass or stainless steel tubing.
 - 4.1.4.1.3 Oxygen piping and fittings for pressures in excess of 49 kg/sq cm gauge shall be of stainless steel or copper alloys.
 - 4.1.4.1.4 Hose connections and hose complying with item 4.1.5.5 may be used to connect the outlet of a manifold pressure regulator to piping providing the working pressure of the piping is 17 kg/sq cm or less and the length of the hose does not exceed 1.5 m.
 - 4.1.4.1.5 Hose shall have a minimum bursting pressure of 70 kg/sq cm.
 - 4.1.4.1.6 When oxygen is supplied to a service piping system from a low-pressure oxygen manifold without an intervening pressure regulating device, the piping system shall have a minimum design pressure of 17 kg/sq cm. A pressure regulating device shall be used at each station outlet when the connected equipment is for use at pressures less than 17 kg/sq cm.
 - 4.1.4.1.7 Piping for acetylene or acetylenic compounds shall be of steel or wrought iron only.
 - 4.1.4.1.8 Copper and copper base alloys shall not be used for acetylene or acetylenic compounds except in approved equipment.
 - 4.1.4.2 Piping Joints
 - 4.1.4.2.1 Joints in steel or wrought iron piping shall be welded, threaded or flanged. Fittings, such as ells, tees, couplings, and unions, may be rolled, forged or cast

- steel, malleable iron or nodular iron. Gray or white cast iron fittings are prohibited.
- 4.1.4.2.2 Joints in brass or copper pipe shall be welded, brazed, threaded, or flanged. If of the socket type, they shall be brazed with silver-brazing alloy or similar high melting point (not less than 427°C) filler metal.
- 4.1.4.2.3 Joints in seamless copper, brass, or stainless steel tubing shall be approved gas tubing fittings or the joints shall be brazed. If of the socket type, they shall be brazed with silver-brazing alloy or similar high melting point (not less than 427°C) filler metal.
- 4.1.4.3 Installation
- 4.1.4.3.1 Distribution lines shall be installed and maintained in a safe operating condition.
- 4.1.4.3.2 All piping shall be protected against physical damage. Proper allowance being made for expansion and contraction, jarring and vibration.
- 4.1.4.3.3 Pipe laid underground shall be protected against corrosion.
- 4.1.4.3.4 Only piping which has been welded or brazed shall be installed in tunnels, trenches or ducts. Shut off valves shall be located outside such conduits. Oxygen piping may be placed in the same tunnel, trench or duct with fuel gas pipelines, provided there is good natural or forced ventilation.
- 4.1.4.3.5 Low points in piping carrying moist gas shall be drained into drip pots constructed so as to permit pumping or draining out the condensate at necessary intervals. Drain valves shall be installed for this purpose having outlets normally closed with screw caps or plugs. No open end valves or petcocks shall be used, except for drips located out of doors or underground and not readily accessible. Valves may be used at such points if they are equipped with means to secure them in the closed position. Pipes leading to the surface of the ground shall be cased or jacketed where necessary to prevent loosening or breaking.
- 4.1.4.3.6 Gas cock valves shall be provided for all buildings at points where they will be readily accessible for shutting off the gas supply to these buildings in any emergency. There shall also be provided a shut off valve in the discharge line from the generator, gas holder, manifold or other source of supply.
- 4.1.4.3.7 Shut off valves shall not be installed in safety relief lines in such a manner that the safety relief device can be rendered ineffective.
- 4.1.4.3.8 Fittings and lengths of pipe shall be examined internally before assembly and, if necessary, freed from scale or dirt. Oxygen piping and fittings shall be washed out with a solution which will effectively remove grease and dirt but will not react with oxygen. Hot water solutions of caustic soda or trisodium phosphate are effective cleaning agents for this purpose.
- 4.1.4.3.9 Piping shall be thoroughly blown out after assembly to remove foreign materials. For oxygen piping, oil-free air, oil-free nitrogen, or oil-free carbon dioxide shall be used. For other piping, air or inert gas may be used.
- 4.1.4.3.10 When flammable gas lines or other parts of equipment are being purged, open lights or other sources of ignition shall not be permitted near uncapped openings.

- 4.1.4.3.11 No welding or cutting shall be performed on an acetylene or oxygen pipeline, including the attachment of hangers or supports, until the line has been purged. Only oil-free air, oil free nitrogen, or oil-free carbon dioxide shall be used to purge oxygen lines.
- 4.1.4.4 Painting and Signs
- 4.1.4.4.1 Underground pipe and tubing and outdoor ferrous pipe and tubing shall be covered or painted with a suitable material for protection against corrosion.
- 4.1.4.4.2 Above ground piping systems shall be marked in accordance with good engineering practice.
- 4.1.4.4.3 Station outlets shall be marked to indicate the name of the gas.
- 4.1.4.5 Testing
- 4.1.4.5.1 Piping systems shall be tested and proved gas tight at 1.5 times the maximum operating pressure, and shall be thoroughly purged of air before placed in service. The material used for testing oxygen lines shall be oil free and noncombustible. Flames shall not be used to detect leaks.
- 4.1.4.5.2 When flammable gas lines or other parts of equipment are being purged of air or gas, sources of ignition shall not be permitted near uncapped openings.
- 4.1.5 Protective Equipment, Hose and Regulators
- 4.1.5.1 Equipment shall be installed and used only in the service for which it is approved and as recommended by the manufacturer.
- 4.1.5.2 Service piping systems shall be protected by pressure relief devices.
- 4.1.5.3 Piping Protective Equipment
- 4.1.5.3.1 The fuel-gas and oxygen piping systems, including portable outlet headers shall incorporate the protective equipment shown in Figures 1, 2 and 3.
- 4.1.5.3.2 When only a portion of a fuel-gas system is to be used with oxygen, only that portion need comply with subparagraph above.
- 4.1.5.3.3 Approved protective equipment (designated P_f in Figures 1, 2 and 3) shall be installed in fuel-gas piping to prevent:
- Back flow of oxygen into the fuel-gas supply system;
 - Passage of a flashback into the fuel-gas supply system; and
 - Excessive back pressure of oxygen in the fuel gas supply system.
- The 3 functions of the protective equipment may be combined in one device or may be provided by separate devices.
- 4.1.5.3.4 The protective equipment shall be located in the main supply line, as in Figure 1 or at the head of each branch line, as in Figure 2 where branch lines are of 50 mm pipe size or larger, protective equipment (designated as P_f) shall be located as shown in either 2 or 3.
- 4.1.5.3.5 Backflow protection shall be provided by an approved device that will prevent flame from passing into the fuel-gas system.

- 4.1.5.3.6 Back-pressure protection shall be provided by an approved pressure-relief device set at a pressure not greater than the pressure rating of the backflow or the flashback protection device, whichever is lower. The pressure-relief device shall be located on the downstream side of the backflow and flashback protection devices. The vent from the pressure-relief device shall be at least as large as the relief device inlet and shall be installed without low points that may collect moisture. If low points are unavoidable drip pots with drains closed with screw plugs or caps shall be installed at the low points. The vent terminus shall not endanger personnel through gas discharge; shall be located away from ignition sources; and shall terminate in a hood or bend.
- 4.1.5.3.7 If pipeline protective equipment incorporates a liquid, the liquid level shall be maintained.
- 4.1.5.3.8 Fuel gas for use with equipment not requiring oxygen shall be withdrawn upstream of the piping protective devices.
- 4.1.5.4 Station Outlet Protective Equipment
 - 4.1.5.4.1 A check valve, pressure regulator, hydraulic seal, or combination of these devices shall be provided at each station outlet, including those on portable headers, to prevent backflow, as shown in Figures 1, 2 and 3 and designated as S_f and S_o .
 - 4.1.5.4.2 When approved pipeline protective equipment (designated as P_f) is located at the station outlet as in Figure 3, no additional check valve, pressure regulator, or hydraulic seal is required.
 - 4.1.5.4.3 A shut off valve (designated J_f and V_o) shall be installed at each station outlet and shall be located on the upstream side of other station outlet equipment.
 - 4.1.5.4.4 If the station outlet is equipped with a detachable regulator, the outlet shall terminate in a union connection.
 - 4.1.5.4.5 If the station outlet is connected directly to a hose, the outlet shall terminate in a union connection.
 - 4.1.5.4.6 Station outlets shall be equipped with a detachable outlet seal cap secured in place. This cap shall be used to seal the outlet except when a hose, regulator, or piping is attached.
 - 4.1.5.4.7 Where station outlets are equipped with approved backflow and flashback protective devices, as many as 4 torches may be supplied from one station outlet through rigid piping, provided each outlet from such piping is equipped with a shut off valve and provided the fuel-gas capacity of any one torch does not exceed 0.42 sq m/hr. This subparagraph does not apply to machines.
- 4.1.5.5 Hose and Hose Connections
 - 4.1.5.5.1 Hose for oxy-fuel gas service shall be according to standards approved by GSMO.
 - 4.1.5.5.2 When parallel lengths of oxygen and acetylene hose are taped together for convenience and to prevent tangling, not more than 10 cm of each 30 cm of length shall be covered by tape.

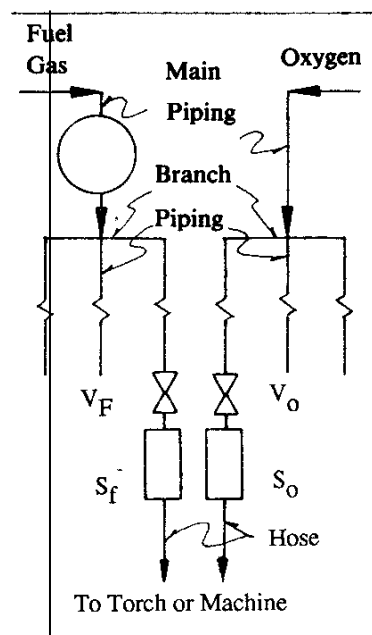


Fig. 1.

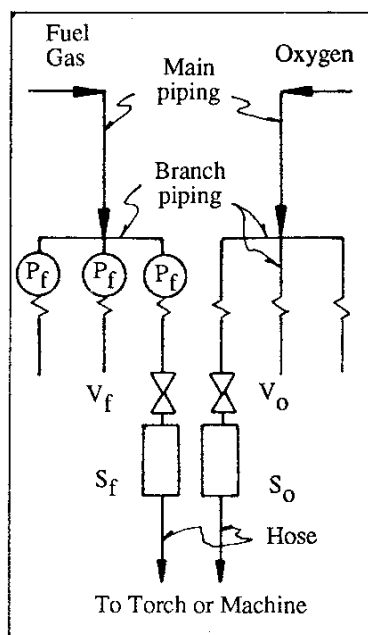


Fig. 2.

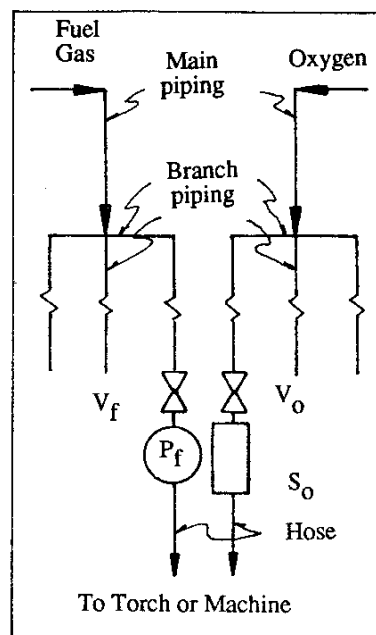


Fig. 3.

LEGEND

Pf-	Protective equipment in fuel gas piping	Sf-	Backflow prevention device(s) at fuel gas station outlet
Vf-	Fuel gas station outlet valve	So-	Backflow prevention device(s) at oxygen station outlet
Vo-	Oxygen station outlet valve		

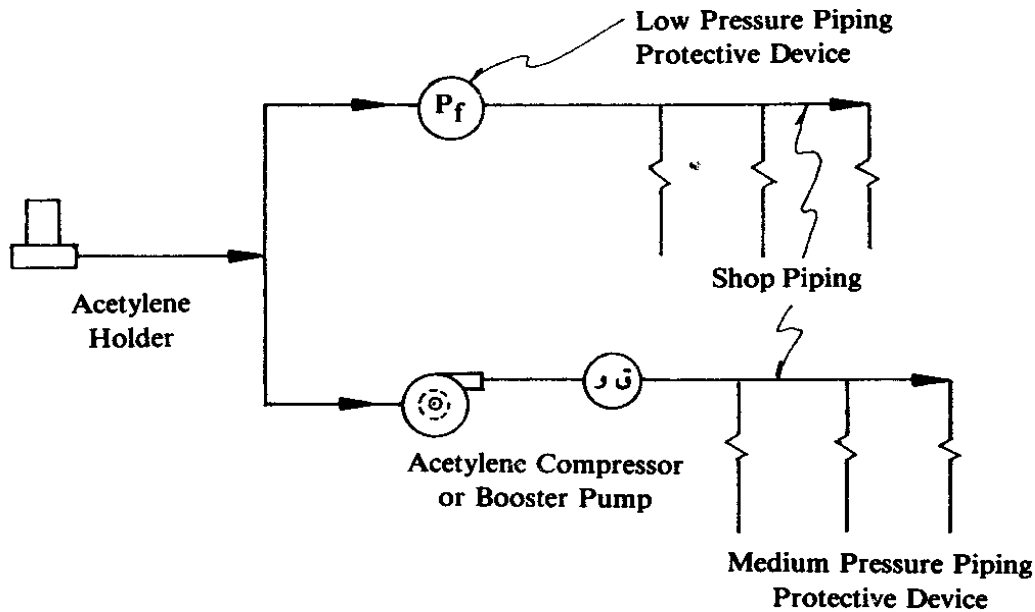


Figure 4

- 4.1.5.5.3 Hose connections shall be clamped or otherwise securely fastened in a manner that will withstand, without leakage, twice the pressure to which they are normally subjected in service, but in no case less than a pressure of 21 kg/sq cm. Oil-free air or oil-free inert gas shall be used for the test.
- 4.1.5.5.4 Hose showing leaks, burns, worn places, or other defects rendering it unfit for service shall be repaired or replaced.
- 4.1.5.6 Pressure-Reducing Regulators
- 4.1.5.6.1 Pressure-reducing regulators shall be used only for the gas and pressures for which they are intended.
- 4.1.5.6.2 When regulators or parts of regulators, including gauges, need repair, the work shall be performed by skilled mechanics who have been properly instructed.
- 4.1.5.6.3 Gauges on oxygen regulators shall be marked "OXYGEN, USE NO OIL". Union nuts and connections on regulators shall be inspected before use to detect faulty seats which may cause leakage of gas when the regulators are attached to the cylinder valves.
- 4.1.6 Acetylene Generators
- 4.1.6.1 Approval and Marking
- Generators shall be according to standards approved by GSMO and shall be plainly marked with the maximum rate of acetylene generation in cubic meter per hour for which they are designed; the weight and size of carbide necessary for a

single charge; the manufacturer's name and address; and the name or number of the type of generator. Carbide shall be of the size marked on the generator nameplate.

4.1.6.2 Rating and Pressure Limitations

4.1.6.2.1 The total hourly output of a generator shall not exceed the rate for which it is approved and marked.

4.1.6.2.2 Relief valves shall be regularly operated to insure proper functioning.

4.1.6.2.3 Relief valves for generating chambers shall be set to open at a pressure not in excess of 1.05 kg/sq cm. Relief valves for hydraulic back pressure valves shall be set to open at a pressure not in excess of 1.4 kg/sq cm.

4.1.6.2.4 Nonautomatic generators shall not be used for generating acetylene at pressure exceeding 0.07 kg/sq cm. and all water overflows shall be visible.

4.1.6.3 Location

The space around the generator shall be ample for free, unobstructed operation and maintenance and shall permit ready adjustment and charging.

4.1.6.4 Stationary Acetylene Generators (Automatic and Nonautomatic)

4.1.6.4.1 Acetylene generators shall be grounded.

4.1.6.4.2 Except when generators are prepared in accordance with item 4.1.6.7, sources of ignition shall be prohibited in outside generator houses or inside generator houses or inside generator rooms.

4.1.6.4.3 Water shall not be supplied through a continuous connection to the generator except when the generator is provided with an open overflow or automatic water shut off which will prevent overfilling of the generator. Where a noncontinuous connection is used, the supply line shall terminate at a point not less than 9 cm above the regularly provided opening for filling so that the water can be observed as it enters the generator.

4.1.6.4.4 Generators shall not be fitted with continuous drain connections leading to sewers, but shall discharge through an open connection into a suitably vented outdoor receptacle or residue pit which may have such connections.

4.1.6.4.5 Each generator shall be provided with a vent pipe.

4.1.6.4.6 The escape or relief pipe shall be rigidly installed without traps, so that any condensation will drain back to the generator.

4.1.6.4.7 The escape or relief pipe shall be carried full size to a suitable point outside the building. It shall terminate in a hood or bend located at least 3.7 m above the ground, preferably above the roof, and as far away as practicable from windows or other openings into buildings, from sources of ignition such as flues or chimneys and tracks used by locomotives. Generating chamber relief pipes shall not be inter-connected. The hood or bend shall be so constructed that it will not be obstructed by rain, insects, or birds. The outlet shall be at least 1 m from combustible construction.

- 4.1.6.4.8 Gas holders shall be constructed on the gasometer principle, the bell being suitably guided. The gas bell shall move freely without tendency to bind and shall have a clearance of at least 50 mm from the shell.
- 4.1.6.4.9 In order to prevent collapse of the gas bell or infiltration of air due to a vacuum caused by the compressor or booster pump or cooling of the gas, a compressor or booster cut-off shall be provided at a point 30 cm or more above the landing point of the bell. When the gas holder is located indoors, the room shall be ventilated and lighted in accordance with item 4.1.6.6.
- 4.1.6.4.10 Means shall be provided to stop the generator-feeding mechanism before the gas holder reaches the upper limit of its travel.
- 4.1.6.4.11 When the gas holder is connected to only one generator, the gas capacity of the holder shall not be less than one-third of the hourly rating of the generator.
- 4.1.6.4.12 If acetylene is used from the gas holder without increase in pressure at some points but with increase in pressure by a compressor or booster pump at other points, approved piping protective devices shall be installed in each supply line. The low-pressure protective device shall be located between the gas holder and the shop piping, and the medium-pressure protective device shall be located between the compressor or booster pump and the stop piping, (see figure 4). Approved protective equipment (designated P_f) shall be used to prevent: Backflow of oxygen into the fuel-gas supply system; passage of a flashback into the fuel-gas supply system and excessive back pressure of oxygen in the fuel-gas supply system. The three functions of the protective equipment may be combined in one device or may be provided by separate devices.
- 4.1.6.4.13 Wiring and electrical equipment in compressor or booster pump room or enclosures shall conform to the provisions of section 7.0 for class 1, Division 2 locations.
- 4.1.6.4.14 Compressors and booster pump equipment shall be located in well-ventilated areas away from open flames, electrical or mechanical sparks or other ignition sources.
- 4.1.6.4.15 Compressor or booster pumps shall be provided with pressure relief valves which will relieve pressure exceeding 1.05 kg/sq cm to a safe outdoor location or by returning the gas to the inlet side or to the gas supply source.
- 4.1.6.5 Portable Acetylene Generators
 - 4.1.6.5.1 Portable generators shall not be used within 3 m of combustible material other than the floor.
 - 4.1.6.5.2 Portable generators shall not be used in rooms of total volume less than 35 times the total gas-generating capacity per charge of all generators in the room. Generators shall not be used in rooms having a ceiling height of less than 3 m.
 - 4.1.6.5.3 Portable generators shall be cleaned and recharged and the air mixture blown off outside buildings.
 - 4.1.6.5.4 Portable generators shall not be stored in rooms in which open flames are used unless the generators contain no carbide and have been thoroughly purged of

acetylene. Storage rooms shall be ventilated at the minimum rate of 2 air changes per hour.

- 4.1.6.5.5 When portable acetylene generators are to be transported and operated on vehicles, they shall be securely anchored to the vehicles. The motor shall be turned off during charging, cleaning, and generating periods.
- 4.1.6.5.6 Portable generators shall be located at a safe distance from the welding position so that they will not be exposed to sparks, slag, or misdirection of the torch flame or overheating from hot materials or processes.
- 4.1.6.6 Outside Generator Houses and Inside Generator Rooms for Stationary Acetylene Generators.
 - 4.1.6.6.1 No opening in any outside generator house shall be located within 1.5 m of any opening in another building.
 - 4.1.6.6.2 Walls, floors, and roofs of outside generator houses shall be of non-combustible construction.
 - 4.1.6.6.3 When a part of the generator house is to be used for the storage or manifold of oxygen cylinders, the space to be so occupied shall be separated from the generator or carbide storage section by partition walls continuous from floor to roof or ceiling of the type of construction for one hour fire rating. Such separation walls shall be without openings and shall be joined to the floor, other walls and ceiling or roof in a manner to effect a permanent gas-tight joint.
 - 4.1.6.6.4 Explosion venting for outside generator houses and inside generator rooms shall be provided in exterior walls or roof. The venting area shall be equal to not less than one sq.m/50 cu m of room volume.
 - 4.1.6.6.5 The installation of acetylene generators within buildings shall be restricted to buildings not exceeding one story in height, except in the roof or top floor of a building exceeding such height.
 - 4.1.6.6.6 Generators installed inside buildings shall be enclosed in a separate room.
 - 4.1.6.6.7 The walls, partitions, floors, and ceilings of inside generator rooms shall be of noncombustible construction having a fire-resistance rating of at least 1 hour. The walls or partitions shall be continuous from floor to ceiling and shall be securely anchored. At least one wall of the room shall be an exterior wall.
 - 4.1.6.6.8 Openings for an inside generator room to other parts of the building shall be protected by a fire door having a rating of at least one hour. Windows in partitions shall be wired glass and metal frames with fixed sash.
 - 4.1.6.6.9 Inside generator rooms or outside generator houses shall be ventilated with vents located at floor and ceiling levels.
 - 4.1.6.6.10 Heating shall be by steam, hot water, enclosed electrically heated elements or other indirect means. Heating by flames or fires shall be prohibited in outside generator houses or inside generator rooms, or in any enclosure communicating with them.
 - 4.1.6.6.11 Generator houses or rooms shall have natural light during daylight hours. Where artificial lighting is necessary it shall be restricted to electric lamps installed in a

fixed position. Unless specifically approved for use in atmospheres containing acetylene, such lamps shall be provided with enclosures of glass or other noncombustible material so designed and constructed as to prevent gas vapors from reaching the lamp or socket and to resist breakage. Rigid conduit with threaded connection shall be used.

- 4.1.6.6.12 Lamps installed outside of wired-glass panels set in gas-tight frames in the exterior walls or roof of the generator house or room are acceptable.
- 4.1.6.6.13 Electric switches, telephones, and other electrical apparatus which may cause a spark, unless specifically designed for use inside acetylene generator rooms, shall be located outside the generator house or in a room or space separated from the generator room by a gas-tight partition, except that where the generator system is designed so that no carbide fill opening or other part of the generator is open to the generator house or room during the operation of the generator, and so that residue is carried in closed piping from the residue discharge valve to a point outside the generator house or room, electric equipment in the generator house or room shall conform to provisions of section 7.0 for Class 1. division. 2 locations.
- 4.1.6.7 Maintenance and Operation
 - 4.1.6.7.1 Unauthorized persons shall not be permitted in outside generator houses or inside generator rooms. Entrances to these rooms shall be so marked.
 - 4.1.6.7.2 Operating instructions shall be posted in a conspicuous place near the generator or kept in a suitable place available for ready reference. When recharging generators the order of operations specified in the instructions supplied by the manufacturer shall be followed.
 - 4.1.6.7.3 In the case of batch-type generators, when the charge of carbide is exhausted and before additional carbide is added, the generating chamber shall always be flushed out with water, renewing the water supply in accordance with the instruction card furnished by the manufacturer.
 - 4.1.6.7.4 The water-carbide residue mixture drained from the generator shall not be discharged into sewer pipes or stored in areas near open flames.
 - 4.1.6.7.5 The carbide added each time the generator is recharged shall be sufficient to refill the space provided for carbide without ramming the charge. Steel or other ferrous tools shall not be used in distributing the charge.
 - 4.1.6.7.6 Generator water chambers shall be kept filled to proper levels, at all times, except while draining during the recharging operation, and whenever repairs are to be made or the generator is to be charged or carbide is to be removed.
 - 4.1.6.7.7 Previous to making repairs involving welding, soldering or other hot work or other operations which produce a source of ignition, the carbide charge and feed mechanism shall be completely removed. All acetylene shall be expelled by completely flooding the generator shell with water and the generator shall be disconnected from the piping system. The generator shall be kept filled with water if possible.
 - 4.1.6.7.8 Hot repairs shall be not made in a room where there are other generators unless all the generators and piping have been purged of acetylene.

4.1.6.8 Calcium Carbide Storage**4.1.6.8.1 Packaging**

4.1.6.8.1.1 Calcium carbide shall be contained in metal packages and be provided with a screw top or equivalent. These packages shall be constructed water and air-tight. Solder shall not be used in such a manner that the package would fail if exposed to fire.

4.1.6.8.1.2 Packages containing calcium carbide shall be conspicuously marked "CALCIUM CARBIDE-DANGEROUS IF NOT KEPT DRY" or with equivalent warning.

4.1.6.8.1.3 Caution: Metal tools, even the so-called spark resistant type, may cause ignition of an acetylene and air mixture when opening carbide containers.

4.1.6.8.1.4 Sprinkler systems shall not be installed in carbide storage rooms. Only dry powder is effective fighting this type of fire.

4.2 Electrical**4.2.1 Application, Installation, and Operation of Arc Welding and Cutting Equipment****4.2.1.1 General**

4.2.1.1.1 Welding equipment shall be installed safely as specified by item 4.2.1.5.

4.2.1.1.2 Workmen designated to operate arc welding equipment shall have been properly instructed and qualified to operate such equipment as specified in item 4.2.1.6.

4.2.1.2 Environmental Conditions

Standard machines for arc welding service shall be designed and constructed to carry their rated load with rated temperature rises where the temperature of the cooling air does not exceed 50°C and where the altitude does not exceed 1490 m, and shall be suitable for operation in atmospheres containing gases, dust, and light rays produced by the welding arc.

4.2.1.3 Voltage

Open circuit (No load) voltages of arc welding and cutting machines should be as low as possible consistent with satisfactory welding or cutting being done. The following limits shall not be exceeded:

4.2.1.3.1 Alternating-current machines

Manual arc welding and cutting - 80 volts

Automatic (machine or mechanized) arc welding and cutting - 100 volts

4.2.1.3.2 Direct-current machine

Manual arc welding and cutting - 100 volts

Automatic (machine or mechanized) arc welding and cutting - 100 volts.

4.2.1.3.3 When special welding and cutting processes require values of open circuit voltages higher than the above, means shall be provided to prevent the operator from making accidental contact with the high voltage by insulation or other means.

- 4.2.1.3.4 For A.C. welding under wet conditions or warm surroundings where perspiration is a factor, the use of reliable automatic controls for reducing no load voltage is recommended to reduce the shock hazard.
- 4.2.1.4 Design
 - 4.2.1.4.1 On all types of arc welding machines, control apparatus shall be enclosed except for the operating wheels, levers, and handles.
 - 4.2.1.4.2 Input power terminals, tap change devices and live metal parts connected to input circuits shall be completely enclosed and accessible only by means of tools.
 - 4.2.1.4.3 Terminals for welding leads should be protected from accidental electrical contact by personnel or by metal objects such as vehicles, crane hooks. etc.
 - 4.2.1.4.4 No connections for portable control devices such as push buttons to be carried by the operator shall be connected to an A.C. circuit of higher than 120 volts. Exposed metal parts of portable control devices operating on circuits above 50 volts shall be grounded by a grounding conductor in the control cable.
 - 4.2.1.4.5 Auto transformers or A.C. reactors shall not be used to draw welding current directly from any A.C. power source having a voltage exceeding 80 volts.
- 4.2.1.5 Installation
 - 4.2.1.5.1 Grounding
 - 4.2.1.5.1.1 The frame or case of the welding machine (except engine-driven machines) shall be grounded under the conditions and according to the methods prescribed in Gulf standard mentioned in item (2.2).
 - 4.2.1.5.1.2 Conduits containing electrical conductors shall not be used for completing a work-lead circuit. Pipelines shall not be used as a permanent part of a worklead circuit, but may be used during construction, extension or repair providing current is not carried through threaded joints, flanged bolted joints, or caulked joints and that special precautions are used to avoid sparking at connection of the work-lead cable.
 - 4.2.1.5.1.3 Chains, wire ropes, cranes. hoists, and elevators shall not be used to carry welding current.
 - 4.2.1.5.1.4 Where a structure, conveyor, or fixture is regularly employed as a welding current return circuit, joints shall be bonded or provided with current collecting devices and periodic inspection should be conducted to ascertain that no condition of electrolysis or shock, or fire hazard exists by virtue of such use.
 - 4.2.1.5.1.5 All ground connections shall be checked to determine that they are mechanically strong and electrically sound for the required current.
 - 4.2.1.5.2 Supply Connections and Conductors
 - 4.2.1.5.2.1 A disconnecting switch or controller shall be provided at or near each welding machine which is not equipped with such a switch or controller mounted as an integral part of the machine. The switch shall be in accordance with the Gulf standard mentioned in item (2.2). Overcurrent protection shall be provided as specified in the Gulf standard mentioned in (2.2). A disconnect switch with overload protection or equivalent disconnect and protection means, permitted by

the Gulf standard mentioned in item (2.2), shall be provided for each outlet intended for connection to a portable welding machine.

- 4.2.1.5.2.2 For individual welding machines, the rated current-carrying capacity of the supply conductors shall be not less than the rated primary current of the welding machines.
- 4.2.1.5.2.3 For groups of welding machines, the conductor rating shall be determined in each case according to the machine loading based on the use to be made of each welding machine and the allowance permissible in the event that all the welding machines supplied by the conductors will not be in use at the same time.
- 4.2.1.5.2.4 In operations involving several welders on one structure, D.C. welding process may require the use of both polarities; or supply circuit limitations for A.C. welding may require distribution of machines among the phases of the supply circuit. In such cases no load voltages between electrode holders will be two times normal in D.C. or 1, 1.41, 1.73, or 2 times normal A.C. machines. Similar voltage differences will exist if both A.C. and D.C. welding are done on the same structure.
- 4.2.1.5.2.5 All D.C. machines shall be connected with the same polarity.
- 4.2.1.5.2.6 All A.C. machines shall be connected to the same phase of the supply circuit and with the same instantaneous polarity.
- 4.2.1.6 Operation and Maintenance
 - 4.2.1.6.1 Before starting operations all connections to the machine shall be checked to make certain they are properly made. The work lead shall be firmly attached to the work; magnetic work clamps shall be freed from adherent metal particles of spatter of contact surfaces. Coiled welding cable shall be spread out before use to avoid serious overheating and damage to insulation.
 - 4.2.1.6.2 Grounding of the welding machine frame shall be checked. Special attention shall be given to safety ground connections of portable machines.
 - 4.2.1.6.3 There shall be no leak of cooling water, shielding gas or engine fuel.
 - 4.2.1.6.4 It shall be determined that proper switching equipment for shutting down the machine is provided.
 - 4.2.1.6.5 Printed rules and instructions covering operation of equipment supplied by the manufacturers shall be strictly followed.
 - 4.2.1.6.6 Electrode holders when not in use shall be so placed that they cannot make electrical contact with persons, conducting objects, fuel or compressed gas tanks.
 - 4.2.1.6.7 Cables with splices within 3 m of the holder shall not be used. The welder should not coil or loop welding electrode cable around parts of his body.
 - 4.2.1.6.8 Maintenance
 - 4.2.1.6.8.1 The operator should report any equipment defect or safety hazard to his supervisor and the use of the equipment shall be discontinued until its safety has been assured. Repairs shall be made only by qualified personnel.

- 4.2.1.6.8.2 Machines which have become wet shall be thoroughly dried and tested before being used.
- 4.2.1.6.8.3 Work and electrode lead cables should be frequently inspected for wear and damage. Cables with damaged insulation or exposed bare conductors shall be replaced. Joining lengths of work and electrode cables shall be by the use of connecting means specifically intended for the purpose. The connecting means shall have insulation adequate for the service conditions.
- 4.2.2 Installation and Operating of Resistance wWelding Equipment
 - 4.2.2.1 General
 - 4.2.2.1.1 All equipment shall be installed by a qualified electrician in conformance with Gulf standard mentioned in item (2.2). There shall be a safety-type disconnecting switch or a circuit breaker or circuit interrupter to open each power circuit to the machine, conveniently located at or near the machine so that the power can be shut off when the machine or its controls are to be serviced.
 - 4.2.2.1.2 Ignition tubes used in resistance welding equipment shall be equipped with a thermal protection switch.
 - 4.2.2.1.3 Workmen designated to operate resistance welding equipment shall have been properly instructed and judged competent to operate such equipment.
 - 4.2.2.1.4 Controls of all automatic or air and hydraulic clamps shall be arranged or guarded to prevent the operator from accidentally activating them.
 - 4.2.2.2 Spot and Seam Welding Machines (nonportable)
 - 4.2.2.2.1 All external weld initiating control circuits shall operate on not more than 120 volts, for the safety of the operators.
 - 4.2.2.2.2 Stored energy or capacitor discharge type of resistance welding equipment and control panels involving high voltage (over 550 volts) shall be insulated and protected by complete enclosures, all doors of which shall be provided with interlocks and contacts wired into the control circuit (similar to elevator interlocks). Such interlocks or contacts shall be so designed as to effectively interrupt power and short circuit all capacitors when the door or panel is open. A manually operated switch or positive device shall be installed, in addition to the mechanical interlocks or contacts, as an added safety measure assuring absolute discharge of all capacitors.
 - 4.2.2.2.3 All doors and access panels of all resistance welding machines and control panels shall be kept locked and interlocked to prevent access, by unauthorized persons, to line portions of the equipment.
 - 4.2.2.2.4 All press welding machine operations, where there is a possibility of the operator's fingers being under the point of operation, shall be effectively guarded by the use of a device such as an electronic eye safety circuit, two hand controls or similar protection.
 - 4.2.2.2.5 The hazard of flying spark shall be eliminated by installing a shield guard of safety glass or fire-resistant plastic at the point of operation. Additional shields or

curtains shall be installed as necessary to protect passing persons from flying sparks.

- 4.2.2.2.6 All foot switches shall be guarded to prevent accidental operation of the machine.
- 4.2.2.2.7 Two or more safety emergency stop buttons shall be provided on all special multispot welding machines, including 2-post, and 4-post weld presses.
- 4.2.2.2.8 On large machines, four safety pins with plugs and receptacles (one in each corner) shall be provided so that when safety pins are removed and inserted in the ram or platen, the press becomes inoperative.
- 4.2.2.2.9 Where technically practical, the secondary of all welding transformers used in multispot, projection and seam welding machines shall be grounded. This may be done by permanently grounding one side of the welding secondary current circuit. Where not technically practical, a center tapped grounding reactor connected across the secondary or the arc of a safety disconnect switch in conjunction with the welding control are acceptable alternates. Safety disconnect shall be arranged to open both sides of the line when welding current is not present.
- 4.2.2.3 Portable Welding Machines
 - 4.2.2.3.1 All portable welding guns shall have suitable counterbalanced devices for supporting the guns, including cables, unless the design of the gun or fixture makes counterbalancing impractical or unnecessary.
 - 4.2.2.3.2 All portable welding guns, transformers and related equipment that is suspended from overhead structures, eye beams, trolleys, etc. shall be equipped with safety chains or cables. Safety chains or cables shall be capable of supporting the total shock load in the event of failure of any component of the supporting system.
 - 4.2.2.3.3 Each clevis shall be capable of supporting the total shock load of the suspended equipment in the event of trolley failure.
 - 4.2.2.3.4 All initiating switches, including retraction and dual schedule switches, located on the portable welding gun shall be equipped with guards capable of preventing accidental initiation through contact with flxturing operator's clothing and so forth. Initiating switch voltage shall not exceed 24 volts.
 - 4.2.2.3.5 The movable holder, where it enters the gun frame, shall have sufficient clearance to prevent the shearing of fingers carelessly placed on the operating movable holder.
 - 4.2.2.3.6 The secondary and case of all portable welding transformers shall be grounded. Secondary grounding may be by center tapped grounding reactor connected across the secondary.
- 4.2.2.4 Flash Welding Equipment
 - 4.2.2.4.1 Flash welding machines shall be equipped with a hood to control flying flash. In cases of high production, where materials may contain a film of oil and where toxic elements and metal fumes are given off, ventilation shall be provided in accordance with item 4.3.2.

- 4.2.2.4.2 For the protection of the operation of nearby equipment, fire-resistant curtains or suitable welds shall be set up around the machine and in such a manner that the operator's movements are not hampered.
- 4.2.2.5 Periodic inspection shall be made by qualified maintenance personnel, and records of the same maintained. The operator shall be instructed to report any equipment defects to his supervisor and the use of the equipment shall be discontinued until safety repairs have been completed.

4.3 Environment

4.3.1 Fire Prevention and Protection

4.3.1.1 The basic precautions for fire prevention in welding or cutting work are:

- 4.3.1.1.1 If the object to be welded or cut cannot readily be moved, all movable fire hazards in the vicinity shall be taken to a safe place.
- 4.3.1.1.2 If the object to be welded or cut cannot be moved and if all the fire hazards cannot be removed, then guards shall be used to confine the heat, sparks, and slag, and to protect the immovable fire hazards.
- 4.3.1.1.3 If the requirements stated above cannot be followed then welding and cutting shall not be performed.

4.3.1.2 Special Precautions

- 4.3.1.2.1 Wherever there are floor openings or cracks in the flooring that cannot be closed, precautions shall be taken so that no readily combustible materials and the floor below will be exposed to sparks which might drop through the floor. The same precautions shall be observed with regard to tracks or holes in walls, open doorways and open or broken windows.
- 4.3.1.2.2 Fire extinguishing equipment shall be maintained in a state of readiness for instant use. Such equipment may consist of pails of water, buckets of sand, hose or portable extinguishers depending upon the nature and quality of the combustible material exposed.
- 4.3.1.2.3 Fire watchers shall be required wherever welding or cutting is performed in locations where other than a minor fire might develop, or any of the following conditions exist:
 - 4.3.1.2.3.1 Appreciable combustible material, in building construction or contents, closer than 11 m to the point of operation.
 - 4.3.1.2.3.2 Appreciable combustibles are more than 11 m away but are easily ignited by sparks.
 - 4.3.1.2.3.3 Wall or floor openings within a 11 m radius expose combustible material in adjacent areas including concealed spaces in walls or floors.
 - 4.3.1.2.3.4 Combustible materials are adjacent to the opposits side of metal partitions, walls, ceilings, or roofs and are likely to be ignited by conduction or radiation.
 - 4.3.1.2.3.5 Fire watchers shall have fire extinguishing equipment readily available and be trained in its use. They shall be familiar with facilities for sounding an alarm in the event of a fire.

They shall watch for fire in all exposed areas, try to extinguish them only when within the capacity of the equipment available, or otherwise sound the alarm. A fire watch shall be maintained for at least a half hour after completion of welding or cutting operations to detect and extinguish possible smoldering fires.

- 4.3.1.2.4 Before cutting or welding is permitted, the area shall be inspected by the individual responsible for authorizing cutting and welding operations. He shall designate precautions to be followed in granting authorization to proceed in the form of a fire permit. See the Gulf standard mentioned in item 2.3.
- 4.3.1.2.5 Where combustible materials such as paper clippings, wood shavings, or textile fibers are on the floor, the floor shall be swept clean for a radius of 11 m. Combustible floors shall be kept wet, covered with damp sand, or protected by fire-resistant shields. Where floors have been water specked, personnel operating arc welding or cutting equipment shall be protected from possible shock.
- 4.3.1.2.6 Cutting or welding shall not be permitted in the following situations:
 - 4.3.1.2.6.1 In areas not authorized by management.
 - 4.3.1.2.6.2 In sprinklered buildings while such protection is impaired.
 - 4.3.1.2.6.3 In the presence of explosive atmospheres (mixture of flammable gases, vapors, liquids, or dusts with air), or explosive atmospheres that may develop inside uncleaned or improperly prepared tanks or equipment which have previously contained such materials, or that may develop in areas with an accumulation of combustible dusts.
 - 4.3.1.2.6.4 In areas near the storage of large quantities of exposed, readily ignitable materials such as bulk sulfur, baled paper, or cotton.
- 4.3.1.2.7 Where practicable, all combustibles shall be relocated at least 11 m from the work site. Where relocation is impracticable, combustible shall be protected with flame proofed covers or other shielded with metal or asbestos guards or curtains. Edges of covers at the floor should be tight to prevent sparks from going under them. This precaution is also important at overlaps where several covers are used to protect a large pile.
- 4.3.1.2.8 Ducts and conveyor systems that might carry sparks to distant combustibles shall be suitably protected or shut down.
- 4.3.1.2.9 Where cutting or welding is done near walls, partitions, ceiling or roof of combustible construction, fire-resistant shields or guards shall be provided to prevent ignition.
- 4.3.1.2.10 If welding is to be done on a metal wall, partition, ceiling or roof, precautions shall be taken to prevent ignition of combustibles on the other side, due to conduction or radiation, preferably by relocating combustibles. Where combustibles are not relocated, a fire watch on the opposite side from the work shall be provided.
- 4.3.1.2.11 Welding shall not be attempted on a metal partition, wall, ceiling or roof having a combustible covering nor on walls or partitions of combustible sandwich-type panel construction.

- 4.3.1.2.12 Cutting or welding on pipes or other metal in contact with combustible walls, partitions, ceilings or roofs shall not be undertaken if the work is close enough to cause ignition by conduction.
- 4.3.1.2.13 Management shall recognize responsibility for the safe usage of cutting and welding equipment on its property and:
 - 4.3.1.2.13.1 Based on fire potentials of plant facilities, establish areas for cutting and welding, and establish procedures for cutting and welding, in other areas.
 - 4.3.1.2.13.2 Designate an individual responsible for authorizing cutting and welding operations in areas not specifically designed for such processes.
 - 4.3.1.2.13.3 Suitably train cutters or welders and their supervisors in the safe operation of their equipment and the safe use of the process.
 - 4.3.1.2.13.4 Advise all contractors about flammable materials or hazardous conditions of which they may not be aware.
- 4.3.1.2.14 The Supervisor:
 - 4.3.1.2.14.1 Shall be responsible for the safe handling of the cutting or welding equipment and the safe use of the cutting or welding process.
 - 4.3.1.2.14.2 Shall determine the combustible materials and hazardous areas present or likely to be present in the work location.
 - 4.3.1.2.14.3 Shall protect combustible from ignition by the following:
 - Have the work moved to a location free from dangerous combustibles.
 - If the work cannot be moved, have the combustibles moved to safe distances from the work or have the combustibles properly shielded against ignition.
 - See that cutting and welding are scheduled that plant operations that might expose combustibles to ignition are not started during cutting or welding.
 - Secure authorization for the cutting or welding operations from the designated management representative.
 - Determine that the cutter or welder secures his approval that conditions are safe before going ahead.
 - Determine that fire protection and extinguishing equipment are properly located at the site.
 - Where fire watches are required, he shall see that they are available at the site.
- 4.3.1.3 Welding or Cutting Containers
 - 4.3.1.3.1 No welding, cutting, or other hot work shall be performed on used drums, barrels, tanks or other containers until they have been cleaned so thoroughly as to make absolutely certain that there are no flammable materials present or any substances such as greases, tars, acids, or other materials which, when subjected to heat, might produce flammable or toxic vapors. Any pipe lines or connections to the drum or vessel shall be disconnected or blanked.
 - 4.3.1.3.2 All hollow spaces, cavities or containers shall be vented to permit the escape of air or gases before preheating, cutting or welding. Purging with inert gas is required.

4.3.2 Protection of Personnel**4.3.2.1 General**

4.3.2.1.1 Helmets and hand shields shall be used during all arc welding or arc cutting operations, excluding submerged arc welding. Goggles shall also be worn during arc welding or cutting operations. The goggles may have either clear or colored glass, depending upon the amount of exposure to adjacent welding operations. Helpers or attendants shall be provided with proper eye protection.

4.3.2.1.2 Goggles or other eye protection shall be used during all gas welding or oxygen cutting operations. Spectacles with side shields and with suitable filter lenses are permitted for use during gas welding operations on light work, for torch brazing or for inspection.

4.3.2.1.3 All operators and attendants of resistance welding or resistance brazing equipment shall use transparent face shields or goggles, depending on the particular job, to protect their faces or eyes, as required.

4.3.2.1.4 Helmets and hand shields shall be made of a material which is an insulator for heat and electricity. Helmets, shields and goggles shall be not readily flammable and shall be capable of withstanding sterilization.

4.3.2.1.5 Helmets shall be provided with filter plates and cover plates designed for easy removal.

4.3.2.1.6 Eye protection equipment shall be in accordance with Gulf standard mentioned in item 2.4.

4.3.2.2 Protection From Arc Welding Ray

Where the work permits, the welder shall be enclosed in an individual booth painted with a finish of low reflectivity such as zinc oxide (an important factor for absorbing ultraviolet radiations) and lamp black, or shall be enclosed with noncombustible screens similarly painted. Booths and screens shall permit circulation of air at floor level. Workers or other persons adjacent to the welding areas shall be protected from the rays by noncombustible or flameproof screens or shields or shall be required to wear appropriate goggles.

4.3.2.3 Protective Clothing

Employees exposed to the hazards created by welding, cutting, or brazing operations shall be protected by personal protective equipment in accordance with Gulf standard mentioned in item 2.4.

4.3.2.4 Work in Confined Spaces

4.3.2.4.1 Confined space means a relatively small or restricted space such as a tank, boiler, pressure vessel, or small compartment of a ship.

4.3.2.4.2 Ventilation is a prerequisite to work in confined spaces. For ventilation requirements see item 4.3.3.

4.3.2.4.3 Where a welder must enter a confined space through a manhole or other small opening, means shall be provided for quickly removing him in case of emergency. When safety belts and lifelines are used for this purpose they shall be so attached to the holder's body that his body cannot be jammed in a small exit opening. An

attendant with a pre-planned rescue procedure shall be stationed outside to observe the welder at all times and be capable of putting rescue operations into effect.

- 4.3.2.4.4 When arc welding is to be suspended for any substantial period of time such as during lunch or overnight, all electrodes shall be removed from the holders and the holders carefully located so that accidental contact cannot occur and the machine disconnected from the power source.
- 4.3.2.4.5 In order to eliminate the possibility of gas escaping through leaks or improperly closed valves, when gas welding or cutting, the torch valves shall be closed and the fuel gas and oxygen supply to the torch positively shut off at some point outside the confined areas whenever the torch is not to be used for a substantial period of time, such as during lunch hour or overnight.
- 4.3.2.4.6 After welding operations are completed, the welder shall mark the hot metal or provide some other means of warning to other workers.
- 4.3.3 Health Protection and Ventilation
 - 4.3.3.1 General
 - 4.3.3.1.1 When welding must be performed in a space entirely screened on all sides, the screens shall be so arranged that no serious restriction of ventilation exists. It is desirable to have the screens so mounted that they are about 60cm above the floor unless the work is performed at so low a level that the screen must be extended nearer to the floor to protect nearby workers from the glare of welding.
 - 4.3.3.1.2 Local exhaust or general ventilating systems shall be provided and arranged to keep the amount of toxic fumes, gases, or dusts below the maximum allowable concentration as specified in Gulf standard mentioned in item 2.5.
 - 4.3.3.1.3 All filler metals and fusible granular materials shall carry the following notice, as a minimum, on tags, boxes, or other containers:

CAUTION

WELDING MAY PRODUCE FUMES AND GASES HAZARDOUS TO HEALTH.

AVOID BREATHING THESE FUMES AND GASES.

USE ADEQUATE VENTILATION.

- 4.3.3.1.4 Brazing (welding) filler metals containing cadmium in significant amounts shall carry the following notice on tags, boxes, or other containers:

WARNING

**CONTAINS CADMIUM - POISONOUS FUMES MAY BE
FORMED ON HEATING**

DO NOT BREATHE FUMES.

**USE ONLY WITH ADEQUATE VENTILATION SUCH AS FUME COLLECTORS,
EXHAUST VENTILATORS, OR AIR-SUPPLIED RESPIRATORS.**

If chest pain, cough, or fever develops after use, call physician immediately.

- 4.3.3.1.5 Brazing and gas welding fluxes containing fluorine compounds shall have a cautionary wording to indicate that they contain fluorine compounds. One such cautionary wording recommended reads as follows:

CAUTION

CONTAINS FLUORIDES

**THIS FLUX WHEN HEATED GIVES OFF FUMES THAT MAY IRRITATE EYES,
NOSE AND THROAT.**

**AVOID FUMES - USE ONLY IN VENTILATED SPACES.
AVOID CONTACT OF FLUX WITH EYES OR SKIN.**

4.3.3.2 Ventilation for General Welding and Cutting

- 4.3.3.2.1 Mechanical ventilation shall be provided when any of the following conditions exist:

4.3.3.2.1.1 Welding or cutting is done on metals not covered in items 4.3.3.3 through 4.3.3.10.

4.3.3.2.1.2 In a space of less than 280 cu m/welder.

4.3.3.2.1.3 In a room having a ceiling height of less than 5 m.

4.3.3.2.1.4 In confined spaces or where the welding space contains partitions, balconies, or other structural barriers to the extent that they significantly obstruct cross ventilation.

4.3.3.2.2 Such ventilation shall be at the minimum rate of 60 cu m/min./welder, except where local exhaust hoods and booths per item 4.3.3.2.3 or respirators for such purposes are provided. Natural ventilation is considered sufficient for welding or cutting operations where the restrictions in item 4.3.3.2.1 are not present.

4.3.3.2.3 Mechanical local exhaust ventilation may be by means of either of the following:

4.3.3.2.3.1 Freely movable hoods intended to be placed by the welder as near as practicable to the work being welded and provided with a rate of airflow sufficient to maintain a

velocity in the direction of the hood of 30 linear m/min. in the zone of welding when the hood is at its most remote distance from the point of welding.

- 4.3.3.2.3.2 A fixed enclosure with a top and not less than two sides which surround the welding or cutting operations and with a rate of air-flow sufficient to maintain a velocity away from the welder of not less than 30 linear m/min.
- 4.3.3.2.4 All welding and cutting operations performed in confined spaces shall be adequately ventilated to prevent the accumulation of toxic materials or possible oxygen deficiency. This applies not only to the welder but also to helpers and other personnel in the immediate vicinity. All air replacing that withdrawn shall be clean and respirable.
- 4.3.3.2.5 In areas immediately hazardous to life, hose masks with blowers or self-contained breathing equipment shall be used. The breathing equipment shall be in compliance with Gulf standard mentioned in item (2.4).
- 4.3.3.2.6 Where welding operations are carried on in confined spaces and where welders and helpers are provided with hose masks, hose masks with blowers or self-contained breathing equipment, a worker shall be stationed on the outside of such confined spaces to insure the safety of those working within.
- 4.3.3.2.7 Oxygen shall never be used for ventilation.
- 4.3.3.3 Fluorine Compounds
 - 4.3.3.3.1 In confined spaces, welding or cutting involving fluxes, coverings, or other materials which contain fluorine compounds shall be done in accordance with items 4.3.3.2.4 through 4.3.3.2.7. A fluorine compound is one that contains fluorine, as an element in chemical combination, not as a free gas.
 - 4.3.3.3.2 The need for local exhaust ventilation or airline respirators for welding or cutting in other than confined spaces will depend upon the individual circumstances. Where air samples taken at the welding location indicate that the fluorides liberated are below 2.5 mg/cu m such protection is not necessary.
- 4.3.3.4 Zinc
 - 4.3.3.4.1 In confined spaces welding or cutting involving zinc-bearing base or filler metals or metals coated with zinc-bearing materials shall be done in accordance with items 4.3.3.2.4 through 4.3.3.2.7.
 - 4.3.3.4.2 Indoors, welding or cutting involving zinc-bearing base or filler metals coated with zinc-bearing materials shall be done in accordance with item 4.3.3.3.
- 4.3.3.5 Lead
 - 4.3.3.5.1 In confined spaces, welding involving lead-base metals (erroneously called lead-burning) shall be done in accordance with items 4.3.3.2.4 through 4.3.3.2.7.
 - 4.3.3.5.2 Indoors, welding involving lead-base metals shall be done in accordance with item 4.3.3.2.3.
 - 4.3.3.5.3 In confined spaces or indoor welding or cutting involving metals containing lead, other than as an impurity, or involving metals coated with lead-bearing materials, including paint, shall be done using local exhaust ventilation or airline respirators. Outdoors, such operations shall be done using respiratory protective equipment.

In all cases, workers in the immediate vicinity of the cutting operation shall be protected as necessary by local exhaust ventilation or airline respirators.

4.3.3.6 Beryllium

Welding or cutting indoors, outdoors, or in confined spaces involving beryllium-containing base or filler metals shall be done using local exhaust ventilation and respirators unless atmospheric tests under the most adverse conditions have established that the workers' exposure is within the acceptable concentrations defined by Section 4.6. In all cases, workers in the immediate vicinity of the welding or cutting operations shall be protected as necessary by local exhaust ventilation or airline respirators.

4.3.3.7 Cadmium

4.3.3.7.1 Welding or cutting indoors or in confined spaces involving cadmium-bearing or cadmium-coated base metals shall be done using local exhaust ventilation or respirators unless atmospheric tests under the most adverse conditions have established that the workers' exposure is within the acceptable concentrations defined by Section 4.6. Outdoors, such operations shall be done using respiratory protective equipment.

4.3.3.7.2 Welding (brazing) involving cadmium-bearing filler metals shall be done using ventilation as prescribed in items 4.3.3.2.3 or 4.3.3.2.4 through 4.3.3.2.7 if the work is to be done in a confined space.

4.3.3.8 Mercury

Welding or cutting indoors or in a confined space involving metals coated with mercury bearing materials including paint, shall be done using local exhaust ventilation or respirators unless atmospheric tests under the most adverse conditions have established that the workers' exposure is within the acceptable concentrations defined by Section 4.6. Outdoors, such operations shall be done using respiratory protective equipment.

4.3.3.9 Cleaning Compounds

4.3.3.9.1 In the use of cleaning materials, because of their possible toxicity or flammability, appropriate precautions, such as manufacturers instructions shall be followed.

4.3.3.9.2 Degreasing or other cleaning operations involving chlorinated hydrocarbons shall be located that no vapors from these operations will reach or be drawn into the atmosphere surrounding any welding operation. In addition, trichloroethylene and perchloroethylene should be kept out of atmospheres penetrated by the ultraviolet radiation of gas-shielded welding operations.

4.3.3.10 Cutting of Stainless Steel

Oxygen cutting, using either a chemical flux or iron powder or gas-shielded arc cutting of stainless steel, shall be done using mechanical ventilation.

4.3.4 Transmission Pipeline

4.3.4.1 The requirements of items 4.2.1, 4.3.2 and 4.3.3 shall be observed.

- 4.3.4.2 Where field shop operations are involved for fabrication of fittings, river crossings, road crossings, and pumping and compressor stations, the requirements of items 4.1.1, 4.2. 1, 4.3.1 and 4.3.3 shall be observed.
- 4.3.4.3 When arc welding is performed in wet conditions, or under conditions of high humidity, special protection against electric shock shall be supplied.
- 4.3.4.4 In pressure testing of pipelines the workers and the public shall be protected against injury by the blowing out of closures or other pressure restraining devices. Also, protection shall be provided against expulsion of loose dirt that may have become trapped in the pipe.
- 4.3.4.5 The connection, by welding, of branches to pipelines carrying flammable substances shall be performed in accordance with good engineering practice.
- 4.3.4.6 The use of X-rays and radioactive isotopes for the inspection of welded pipeline joints shall be carried out in conformance with Gulf standard mentioned in item 2.6.
- 4.3.5 Mechanical Piping System
 - 4.3.5.1 The requirements of all paragraphs of this section shall be observed.
 - 4.3.5.2 The use of X-rays and radioactive isotopes for the inspection of welded piping joints shall be in conformance with Gulf standard mentioned in item 2.6.